Space Weather Technical Forecast

Issued on Saturday, 09 December 2023 at 12:19 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

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Space Weather Forecast Headline: Chance of R1-R2 throughout.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity was Moderate due to a pair of impulsive flares from AR3511, an M5.4 at 08/2307UTC and a M1.5 at 09/0955UTC.

There are currently eight numbered regions on the disc. AR3511 in the southwest remains the largest and most magnetically complex group (Fso/Beta-Delta), with further growth evident and a delta spot configuration in one of the lead portion spots. The other large bipolar spot group in the northeast has moderate magnetic complexity (Eai/Beta-Gamma), with growth and consolidation observed in its main lead spot in recent hours. Remaining spot groups are smaller and magnetically simpler, and show only small changes in recent imagery.

No new Earth-directed Coronal Mass Ejections (CMEs) were evident in available imagery. Some faint and slow ejecta was discernible following the M5.4, which was modelled but does not indicate any significant impacts at Earth.

Solar Wind / Geomagnetic Activity: Solar winds, as measured by ACE and DSCOVR at L1, were reflective of a gradual exit from the recent fast solar wind regime from CH76/-. Wind speeds showed a slow decline through Slightly Elevated levels in the 24 hours, falling from 450 to 410km/s. Density was near the long-term average in single figures ppcc. The IMF showed a roughly level tendency near background, 2 to 5nT, while the north-south component ranged between +4 and -4nT. The phi angle towards the Sun throughout (negative). The resultant geomagnetic activity was Quiet (Kp 0 to 2) throughout.

Energetic Particles / Solar Radiation: GOES16 high energy (greater than 10MeV) proton flux remained at Background levels.

GOES16 high energy (greater than 2MeV) electron flux was predominantly at Moderate levels, but very briefly reached High levels, peaking at 1400pfu at 08/1520UTC. The associated 24-hour fluence has remained below the Active threshold (1e8 integrated pfu), and on a broadly flat trend. The observation at 09/0001UTC was 6.63e7 integrated pfu.

Four-Day Space Weather Forecast Summary

Solar Activity: Solar activity carries a Chance of further M-class flares, with potential sources most likely to be AR3511 and perhaps also AR3513. Chances drop slightly on day four (Tuesday 12 December), with the expected departure of several western solar hemisphere regions including AR3511, and a relative lack of oncoming eastern limb replacements.

Solar Wind / Geomagnetic Activity: There is one marginal CME in the forecast, with a glancing blow from the 07 December northeastern quadrant filament perhaps coinciding with a CIR from the high speed stream leading CH77/+ late on Sunday 10 December. Elevated speeds

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may be reached, with the combined effect potentially resulting in a peak Slight Chance of a G1/Minor Geomagnetic Storm interval, perhaps extending into Monday 11 December, and which may be further complimented by any fast wind from small CH80/+.

Energetic Particles / Solar Radiation: GOES16 high energy proton flux carries a daily Slight Chance of S1/Minor Storm or greater conditions being reached, with AR3511 the most likely source.

Electron flux levels are likely to see diurnal peaks to a similar level to recent days over the coming UTC weekend, probably attenuated at GEO into the new working week given the onset of coronal hole activity and possible CME glancing influence.

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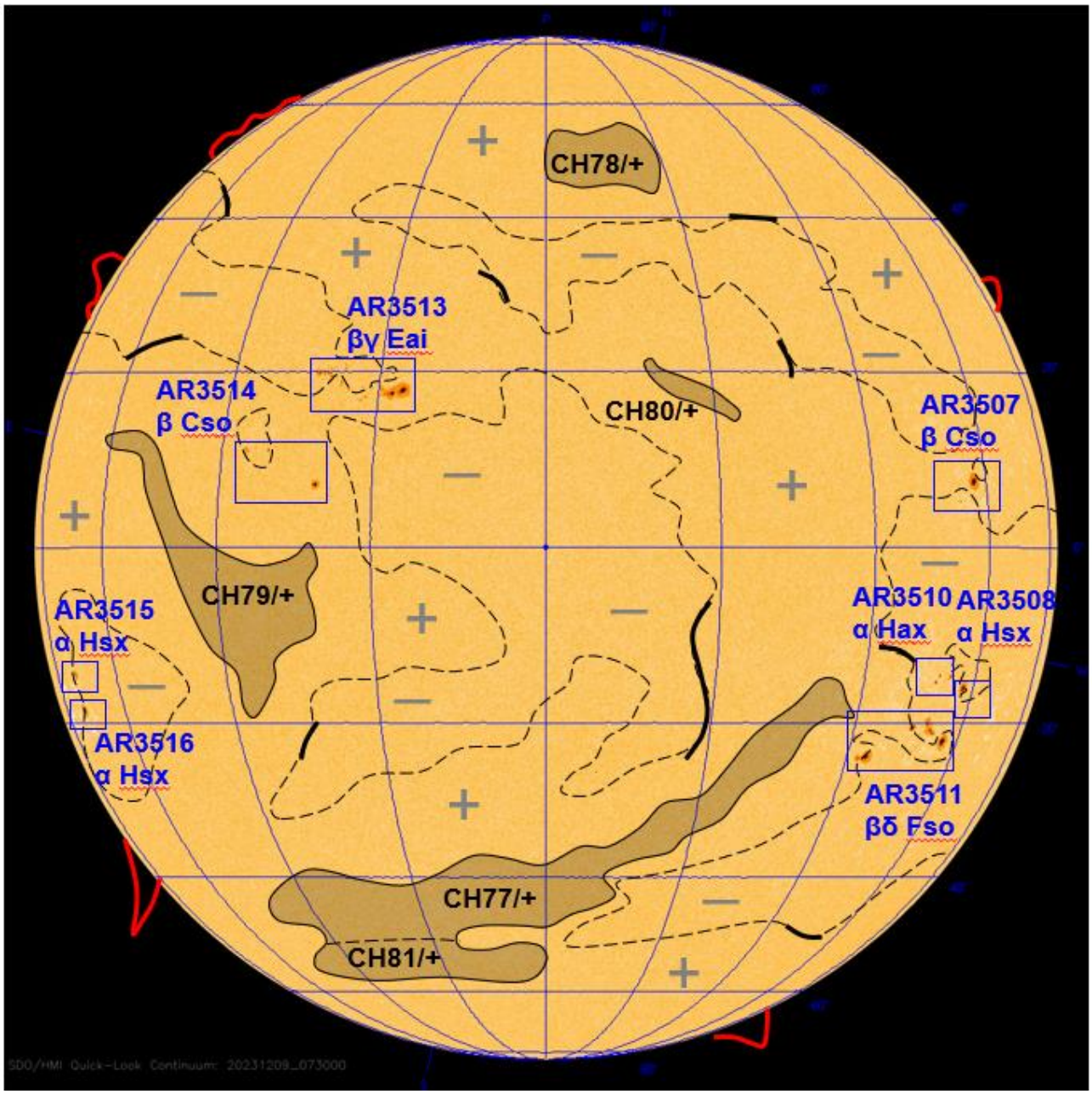
Figure 1. Solar Analysis Valid 09/0800UTC.



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Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Met Office Space Weather Technical Forecast

Geomagnetic Storms:

The geomagnetic forecast comprises one possible CME - that from 07/0200UTC seen leaving the northeast quadrant. The weight of evidence from MOSWOC Enlil's ensemble suggests that this could give a weak glancing blow later on Sunday 10 December, although this is likely to be influenced to a large extent by Enlil's handling of the large but well south CH77/+, with some interaction between any CIR leading this feature and the side-lobe of the aforementioned CME possible. This offers a peak risk of G1 for the four-day period, probably continuing into the new working week to some degree, and perhaps further maintained by a small positive coronal hole currently near centre-disc: CH80/+. The most reliably quiet period in the forecast is therefore the start of the UTC weekend, with confidence falling more sharply than is typical with time given the interplay between several marginal features, although confidence in any impact being small is higher.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	1	20	10	1
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
07/1302	Partial	Filament	NE	406 km/s	Late 10 Dec	Low confidence glancing blow

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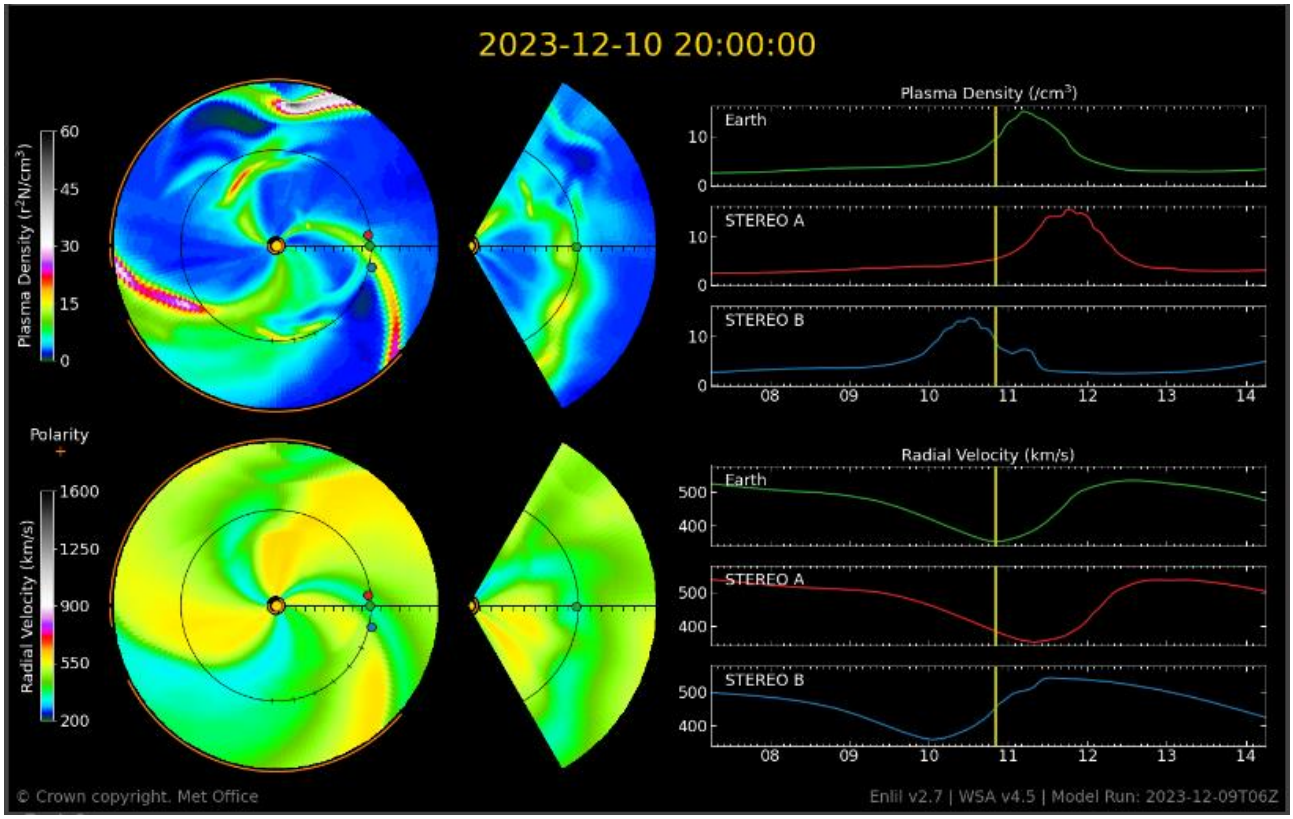
Figure 2: MOSWOC Enlil showing predicted faster stream of solar wind from CH77, and possible concurrent weak CME glance.



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Radio Blackouts - X-Ray Flares:

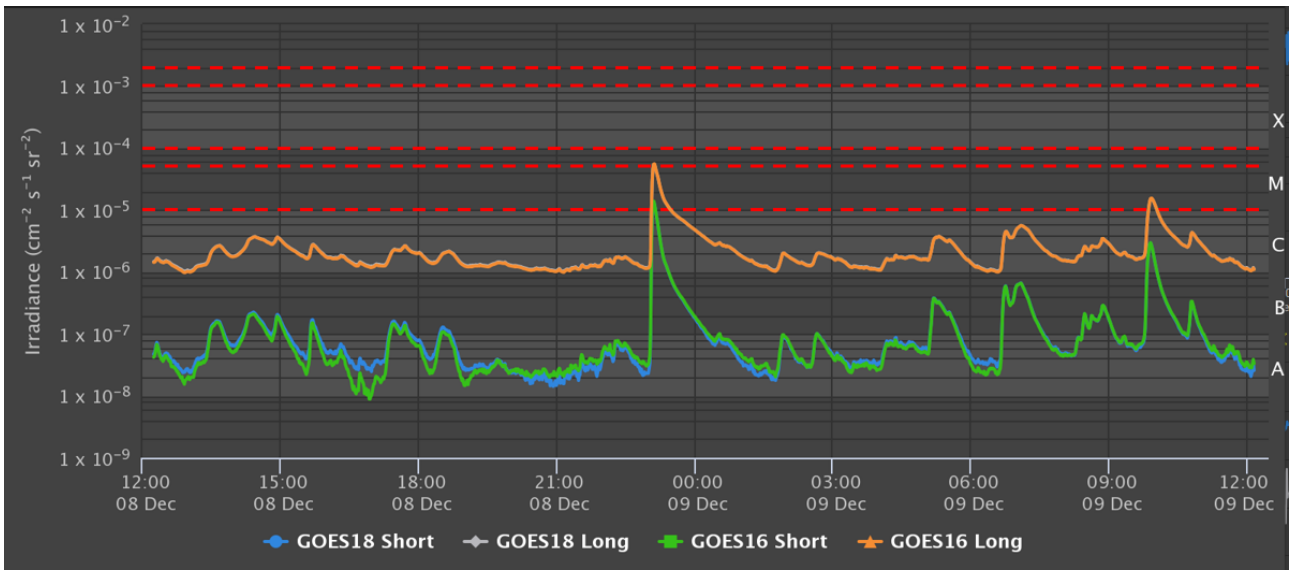
Solar activity was Moderate due to a pair of impulsive flares from AR3511, an M5.4 at 08/2307UTC and a M1.5 at 09/0955UTC. There is a chance of further M-class flares, with a slight chance of an X-class event.

There are currently eight numbered regions on the disc. AR3511 in the southwest remains the largest and most magnetically complex group (Fso/Beta-Delta), with further growth evident and a delta spot configuration in one of the lead portion spots. The other large bipolar spot group in the northeast has moderate magnetic complexity (Eai/Beta-Gamma), with growth and consolidation observed in its main lead spot in recent hours. Remaining spot groups are smaller and magnetically simpler, and show only small changes in recent imagery.

Neither far-side soundings nor returning Carrington locations suggest any significant upcoming groups over the eastern solar horizon, while on the west, up to three groups are due to depart on Tuesday 12 December. This is expected to lead to an overall slight drop in the daily chance of M-class flares later in the period.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	Yes	50	50	50	40
Very Active	R3 to R5 X Class	No	10	10	10	5

Figure 3: GOES16 and 18 X-ray flux showing the pair of M-class flares.



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Solar Radiation Storms - (High Energy Protons):

The high energy (greater than 10MeV) proton flux observed by GOES16 is currently at Background levels. There is a daily Slight Chance of S1/Minor Storm or greater conditions being reached, with AR3511 by far the most likely source given its recent activity and its favourable geoeffective position in the western disc.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	15	15	10	10
Very Active	**≥ S3 ***	No	1	1	1	1

* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)

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High Energy Electrons Event (≥ 2MeV):

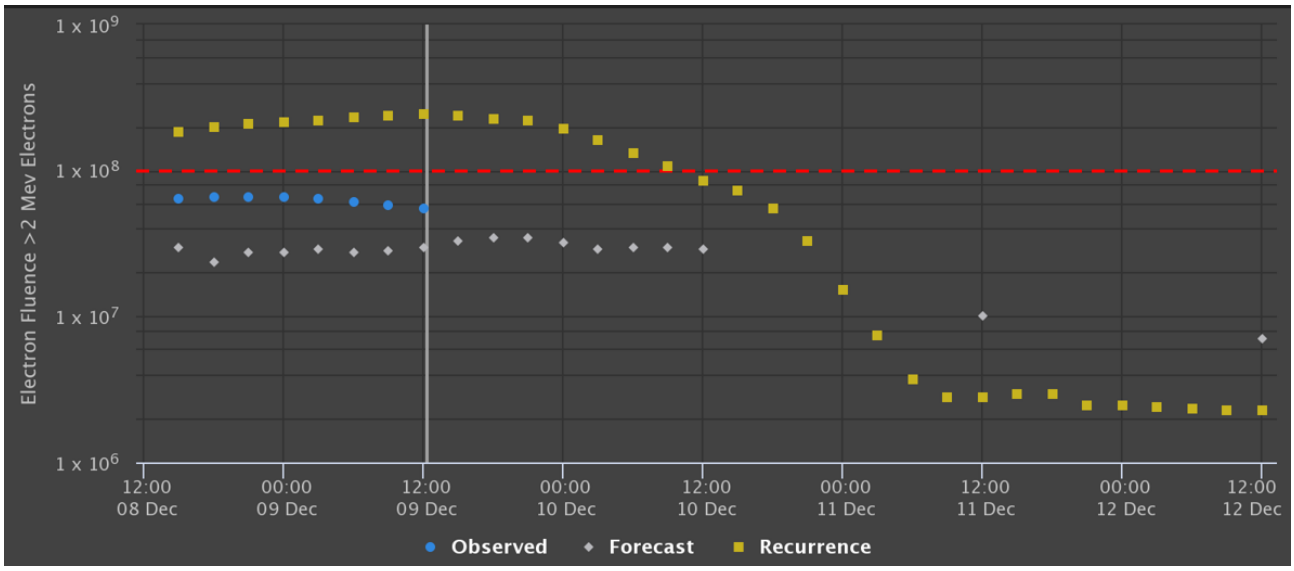
The influence from CH76/- has waned, meaning electron flux levels should plateau near current values over the coming UTC weekend, likely falling narrowly short of Active 24-hour integrated fluence. There is then likely to be suppression at GEO under the increase in geomagnetic activity arising from a likely second fast wind (from CH77/+), and perhaps also the glancing influence of 07 December CME.

A gradual recovery should then ensue into the new working week as likely brief geomagnetic activity wanes, although there is the question mark of any further influence from small CH80/+ which may further delay increases at GEO. All considered, coronal holes in the period are considered relatively modest in stature, and the likelihood is that fluence levels remain below Active for the duration.

MOSWOC REFM maintains fluence below 1e8 through the next 72 hours, and persistence shows a precipitous drop, although neither is felt to offer a good handle on upcoming conditions given the possible presence of a CME.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	No	30	30	10	20
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

Figure 4: MOSWOC REFM latest output.



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